NOMAD: Injecting Mobile Active Probes for Network Operational Measurement and Diagnosis

Abstract

Leading edge Active Nets research funded by DARPA promises to stimulate a revolution in the manner that networks are designed and deployed. Currently, data flows through a network switching system in the form of packets or cells. The switching nodes simply relay data from hop-to-hop in order to provide connectivity between sources and sinks. The functionality provided by each node remains relatively fixed, so the switching algorithms that operate on each packet or cell provide fairly uniform handling among a few service classes, such as constant bit rate, available bit rate, and variable bit rate. Active Nets research will lead to network switching nodes that can be programmed on a packet-by-packet basis. In effect, switching nodes in the network will include an execution environment, akin to a virtual machine, where packets can encapsulate code fragments to execute during switching, and where packets can deposit code fragments that provide unique handling for specific incoming data. Subsequent packets can augment, override, or delete previously injected code fragments. This Active Nets technology will open up significant opportunities for innovative approaches to network measurement.

Active Net nodes will provide an environment into which mobile active probes can be injected to perform sophisticated, programmable network measurement and diagnosis. Several innovations might prove possible. First, since active probes contain programs that can be deposited on specific nodes internal to a network, it should be easy to design, implement, and then activate new measurement types within an already deployed network. This means that new measures can be devised for specific experiments or diagnoses independent of upgrading the software on deployed switching nodes. Every conceivable measurement need not be determined in advance, nor must all available measurements be supported in all nodes at all times. Second, since code for interpreting measurements can be moved onto the node collecting the measures, the measurement latency and network overhead typically associated with remote measurement (using say the Simple Network Management Protocol, or SNMP) can be avoided. Third, since the active probes can move, it might prove feasible to develop diagnostic algorithms that use configurable, distributed points of observation and control inside the network. Further, one can imagine diagnostic probes that are deployed, sample specific conditions, and then move through the network toward points of trouble based on repeated samples taken along their trajectories.

We propose to complete four tasks. (1) We will deploy an Active Nets environment, chosen from among the three or four being funded by DARPA. (2) We will develop NOMAD, a prototype mobile-active-probe system for network operational measurement and diagnosis. (3) We will demonstrate the injection, overriding, and deletion of active probes. (4) We will experiment with a few diagnostic algorithms based on mobile active

probes. We expect that this work would lead to a competency proposal for advanced network measurement techniques based on mobile active probes.

Proposed Deliverables

Task 1   Deploy an Active Nets environment

Task 2   Develop NOMAD, a prototype active probe system for network operational measurement and diagnosis

Task 3   Demonstrate injection, overriding, and deletion of active probes

Task 4   Experiment with one diagnostic algorithm based on mobile probes